other actions that birds perform with the wings expanded, the point of the wing must remain extended to a degree correspondent to the amount of extension of the forearm; and particularly, in all terrestrial and aquatic progression, when the wings are not used, as well as in a state of rest (and, it is hardly necessary to add, by far the greater part of a bird's time is spent in one or the other of these conditions), the weight of the distal segment of the wing is largely supported, and the point of the wing somewhat fixed in its folded position, by the flexion of the forearm upon the humerus.

Independently of the obvious anatomical necessity for some such bony arrangement as has been described, and in a purely physiological point of view, it is no exaggeration of the import of this osseous mechanism to say, that by its means the action of the brachialis anticus, biceps, and triceps, is transmitted to the very end of the distal segment of the wing; that it accomplishes a part of the work that the muscles would otherwise have to perform, and tends to equalize muscular action, by taking some of the strain off the smaller muscles that act upon the hand, and relegating a part of their work to the larger ones of the upper arm.

3. On the Characteristics of the Primary Groups of the Class of Mammals. By Dr. Theodore Gill, of Washington, D. C.

General.

At the last meeting of the Association, the author made a communication on the classification of mammals, based on facts in part already become the common property of science, and in part previously unpublished. An abstract giving the conclusions arrived at has been published in "The American Naturalist" and in the "Proceedings" of the Association. Continued researches into the same subject have confirmed the propriety of the ordinal groups and the limits then admitted, but have necessitated a different combination of those groups.

The divisions into subclasses first solidly established by Huxley are still retained.

The Placental or Monodelphian mammals are with more propriety combinable into two major groups which correspond — on the one hand, to the EDUCABILIA of Bonaparte (the combined ARCHENCEPHALA and GYRENCEPHALA of Owen, and the combined ARCHONTS and MEGASTHENES of Dana); and on the other hand, to the INEDUCABILIA of Bonaparte (the LISSENCEPHALA of Owen and the MICROSTHENES of Dana). The characters hitherto used to distinguish those groups are, however, either vague and difficult of application, not characteristic, or generally regarded as inapplicable. But positive and easily recognizable characters appear to exist in the brain which confirm those groups, but which have not hitherto been regarded, at least in respect to their systematic application.

There has also always existed cause to deplore the insufficiency of the characters assigned in the diagnoses of some of the orders of mammals. After an attentive study of most of the known forms, the author believes that he has succeeded in finding characters which at the same time confirm the groups already recognized and supplement the teleological characters (sometimes of doubtful application or entirely failing) by morphological characters of more constancy. The revised diagnoses of the orders and other primary divisions are submitted in advance of a work now being printed by the Smithsonian Institution; that work will give the characters, contrasted in dichotomous tables, of all the groups of mammals as low as subfamilies and lists of the genera, recent and extinct. While the author has been dependent, for the most part, on the collections of the Smithsonian Institution for his investigations, he has also visited the museums of the Academy of Natural Sciences of Philadelphia, the Peabody Academy of Science of Salem, the Boston Society of Natural History, and the Museum of Comparative Zoölogy at Cambridge.

Principles of Classification.

It is proper to repeat here the principles which have guided the author in the appreciation of the relations of the various groups admitted, and their combination. These are the following five: —

I. Morphology is the only safe guide to the natural classification of organized beings; teleology or physiological adaptation the most unsafe and conducing to the most unnatural approximations.

II. The affinities of such organisms are only determinable by the sum of their agreements in morphological characteristics, and not by the modifications of any single organ.

III. The animals and plants of the present epoch are the derivatives with modification of antecedent forms to an unlimited extent.

IV. An arrangement of organized beings in any single series is, therefore, impossible, and the system of sequences adopted by genealogists may be applied to the sequence of the groups of natural objects.

V. In the appreciations of the value of groups, the founder of modern taxonomy (Linnæus) must be followed, subject to such deviations as our increased knowledge of structure necessitates.

I.

The first of these principles is almost universally accepted by scientific naturalists, although popular writers still frequently urge, as reasons for certain classifications of animals, that modifications of the general form, or of special organs, are subservient to the use of the animal; such teleological modifications, however, are really provocative of suspicion of their taxonomic significance.

II.

The second proposition is also very generally adopted by scientific naturalists, at least in practice, but my learned friend, Professor Cope, — in his very able and instructive memoir on the classification of the reptiles,* — while expressing a general approbation of the principles just enumerated, has combated the one in question; he conceives "it to be a very good expression of the views of many naturalists, yet, in [his] own, it does not go far enough; nor is the second clause, that 'affinities are determinable' 'not by the modifications of any single organ,' one with which [he] can agree. The same objection, therefore, applies to the corollary following, that the 'adoption of such principles compels us to reject such systems as are based solely on modifications of the brain, those of the placenta, and those of the organs of progression,' &c. In other words, agreeing with the first part of Proposition II., that 'affinities are only determinable by the sum of their agreement in morphological characteristics,' [he does] not regard the remainder

* Cope, Proc. Am. Ass. Adv. Sci., 19 meeting (1870), p. 226, 1871.

of the proposition and its corollary as necessary consequences of it."

I am happy to believe that there is only an apparent and no real difference between my eminent friend and myself, and that some misunderstanding has resulted on his part in an unconscious interpretation of the clause "affinities are only *determinable*," used in the proposition quoted, by something like the phrase "groups are only *diagnoscible*." I however deliberately used the former, and in the hope that my meaning might be clear, and not interpreted in the sense of the latter. I therefore reassert that the affinities of animals are only *determinable* by the sum of their agreements in *morphological* characteristics (and Professor Cope *in practice* adopts the principle), but freely assent to the proposition that natural groups *thus ascertained* may be *diagnoscible* by the expression of the modification of a single organ, and have acted upon it in the article quoted and in the present. And that Professor Cope has acted on the proposition that affinities are not "*determinable*" by the modifications of a single organ, but by their agreement in whole, is evident from his writings, and his practice in the article from which I have just quoted. For example, he there combines the *orders* of reptiles with "extremities differentiated" into major groups, primarily distinguished by the relations of the tubercular and capitular portions of the ribs.* Yet in the *order* of cetaceous mammals, he assigns a very inferior value to corresponding modifications of the articular surfaces of the ribs,† co-ordinating them with family characters. Now, there is no *à priori* reason that I am aware of, why these modifications should not be of as much taxonomic value in the one case as in the other. If, for example, we had only two reptiles, and two mammals, respectively exhibiting such differentiation as to the ribs among themselves, that differentiation having just originated, I know not what reason we would

* "Tubercular and capitular surfaces united," in SYNAPTOSAURIA, *i.e.* *Rhynchocephalia*, *Testudinata*, and *Sauropterygia*; Tubercular and capitular surfaces separated; former on diapophysis, latter on centrum," in ARCHOSAURIA, *i.e.* *Anomodontia*, *Dinosauria*, *Crocodilia*, and *Ornithosauria*.

† "The hinder ribs losing their tubercle and retaining their capitular articulations with the vertebræ," in *Physeteridæ*. "The tubercular and capitular articulations of the ribs blending together posteriorly," in *Platanistidæ*. "Posterior ribs losing their capitular articulation, and only uniting with the transverse processes of the vertebræ by the tubercle," in *Delphinidæ*. — Cope, Proc. Acad. Nat. Sci., Phila., 1869, p. 20.

have to foresee a constantly increasing differentiation as to other points of structure in the one more than in the other. But as a matter of fact, we do see that there has been such differentiation in the reptiles (admitting, for the sake of argument at least, the naturalness of the associations sanctioned by Cope), and that co-ordinated with such characters are others which stamp them as "natural groups," while it is still more evident that in the case of the cetaceans, primary combinations distinguished by the rib-articulations would be solely based thereon, and that such modifications are not co-ordinate with others, and are therefore not indicative of true affinity. This has been fully recognized by Professor Cope; he has *determined* the affinities of the reptiles by an appreciation of their common agreements, has verified the constancy of the mode of articulations of the ribs, and their co-ordinations with other characteristics, and has therefore availed himself of the obvious characters furnished thereby for *diagnostic* purposes; on the other hand, he has appreciated the affinities *inter se* of the cetaceans, has verified the comparatively slight value of the mode of articulation of the ribs, and the absence of correlation with other characters, and has therefore properly limited the taxonomic value to family rank, and introduced them into the *diagnoses* of the families. In neither case, are the groups *made* simply because they are distinguished by their rib-articulations; they are *recognized* because of certain general agreements *inter se*, and the rib-articulations simply furnish good *technical* means for their further recognition and distinction. In practice, then, I repeat, there is no disagreement between us; and a proper distinction between the words *determinable* and *diagnoscible* would prevent any theoretical disagreement.

III.

The third proposition (respecting descent with modification) is too generally admitted by competent judges to need argument in this place.

IV.

A difficult problem is the arrangement, in a linear series, of forms so as to best express their relationships. This is perhaps most aptly effected by taking, in the first place, the most generalized type known (a), and follow that by the one (of two or more) most closely allied to it (a 1), then by the one nearest to that (a 2), and

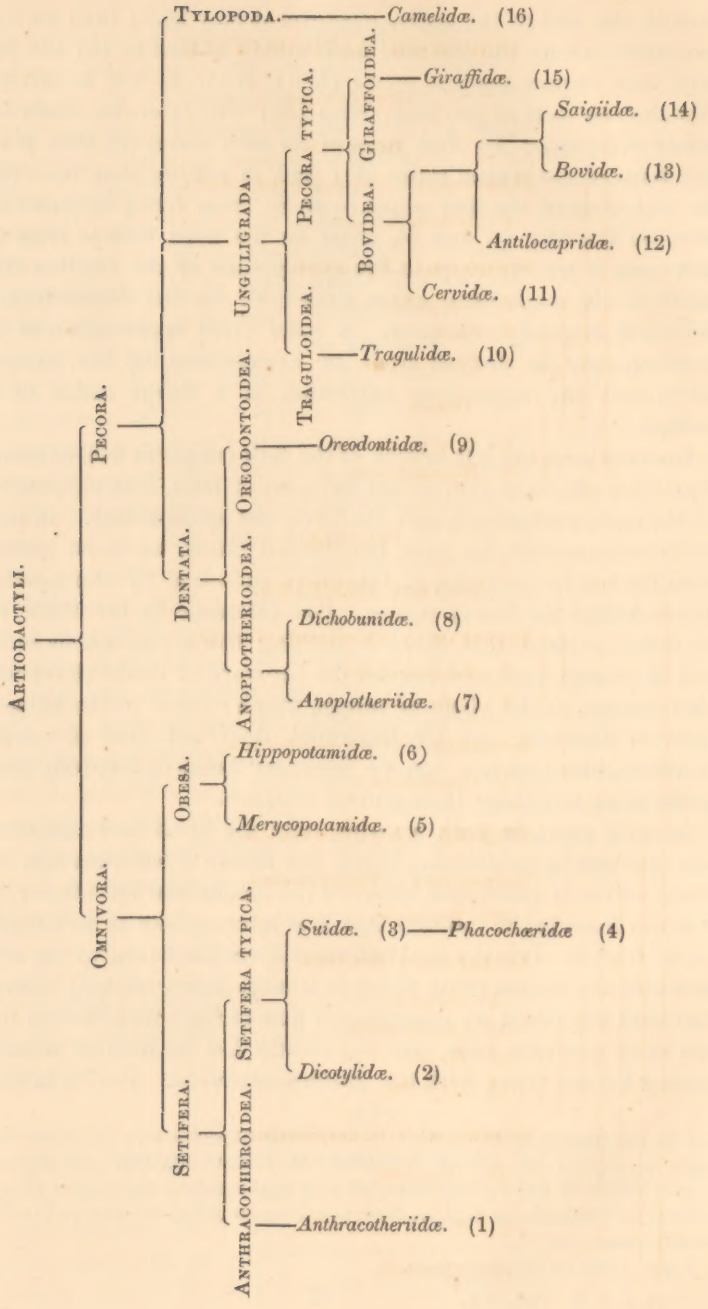
thus to the end of the series, wherever it may lead; then we may recommence with the one *next* most nearly related to (*a*) the first type, and project another series (*b*, *b*1, &c.). It will be evident that the last term of the first series (*ax*) will often be much less nearly related to the first term of its own series (*a*) than is the first term of the second series (*b*); and, of course, that it, — (*ax*) the last term of the first series, — so far from being intermediate between the two (*a* and *b*), must be the most remote from the first term, if we are right in the appreciation of the relative affinities* of the succeeding series, since both are the descendants of the same original progenitor. A more vivid appreciation of our meaning may be derived from an examination of the annexed table, and the succeeding exhibition in a linear series of its terms.†

In every case, the left branch of the fork (major as well as minor) represents the most generalized form, or, at least, that supposed to be the most generalized, and therefore the quasi-eldest. If, then, we commence with the most generalized forms, we must proceed from the left to the right, in the order indicated by the numbers inserted after the family names. But reference to the table will render it evident that there is nothing like a continuous series; and it is now removed beyond the province of doubt that such a phenomenon as the chain of beings, which existed in the imaginations of Lamarck and De Blainville, does not exist in nature; therefore, in no scheme can we interpose forms in a strictly linear series so as to exhibit their mutual affinities.

In most cases, in such a series, only the proximate affinities in one case can be exhibited. Thus, the family *Phacochœridæ*, in a linear series, is interposed between the *Suidæ* and the *Obesa;* but it is not intended to indicate that it is intermediate as to affinities, — far from it. It is the final and most specialized term of the series to which the former (with which it is most nearly related) belongs; and with the *Obesa* we commence a new series, which springs from the same common base, and apparently has its nearest relations among known types, with the *Anthracotheriidæ*. But to indicate

* In this respect, however, we must frequently expect to err; for, when called upon to express our opinion respecting the relative affinities and degree of generalization of three given forms, we may arrive at false conclusions from the paucity of material, as well as from attaching an undue importance to certain modifications.

† See Table on following page.


Artiodactyli.
Pecora.
Omnivora.
Tylopoda.
Camelidæ. (16)
Dentata.
Unguligrada.
Pecora typica.
Giraffoidea.
Giraffidæ. (15)
Bovidea.
Saigiidæ. (14)
Bovidæ. (13)
Antilocapridæ. (12)
Cervidæ. (11)
Traguloidea.
Tragulidæ. (10)
Oreodontoidea.
Oreodontidæ. (9)
Anoplotherioidea.
Dichobunidæ. (8)
Anoplotheriidæ. (7)
Obesa.
Hippopotamidæ. (6)
Merycopotamidæ. (5)
Setifera.
Setifera typica.
Suidæ. (3)—Phacochœridæ (4)
Dicotylidæ. (2)
Anthracotheroidea.
Anthracotheriidæ. (1)

SUBORDER ARTIODACTYLI.

OMNIVORA.

SETIFERA.

SUPERFAMILY ANTHRACOTHEROIDEA.

1 *Anthracotheriidæ.*

SUPERFAMILY SETIFERA.

2 *Dicotylidæ.*
3 *Suidæ.*
4 *Phacochœridæ.*

OBESA.

5 *Merycopotamidæ.*
6 *Hippopotamidæ.*

PECORA.

PECORA DENTATA.

SUPERFAMILY ANOPLOTHERIOIDEA.

7 *Anoplotheriidæ.*
8 *Dichobunidæ.*

SUPERFAMILY OREODONTOIDEA.

9 *Oreodontidæ.*

PECORA UNGULIGRADA.

SUPERFAMILY TRAGULOIDEA.

10 *Tragulidæ.*

SUPERFAMILY BOOIDEA.

11 *Cervidæ.*
12 *Antilocapridæ.*
13 *Bovidæ.*
14 *Saigiidæ.*

SUPERFAMILY GIRAFFOIDEA.

15 *Giraffidæ.*

PECORA TYLOPODA.

16 *Camelidæ.*

the termination of series, a new designation has been introduced, — the superfamily, — and it is to be understood that the second group originates either from the same common progenitor as the first, or from a representative of the first group. The serial exposition of the Artiodactyli will serve to illustrate the application of these principles.

The various relations and inter-relations of the families, or rather the views of the author respecting them, may be also ascertained by the braces connecting them; and it may not be superfluous to recall the statement that the affinities of the respective groups are apparent in the first or more generalized of each series, and that indeed it would be a matter, in the present state of our knowledge, of little moment whether we placed one or the other of two terms first, — whether, for example, we place the *Unguligrada*, or the family of camels, after the *Pecora dentata* (from some form of which it has probably been directly derived rather than from any of the specialized Unguligrade forms). For if, in some respects, the Unguligrades seem to furnish a less interrupted series from the *Pecora dentata*, the camels do in others. As, however, on the whole, the relations of the latter are less obvious, and as they exhibit several very specialized features, the present state of our knowledge seems better to be exhibited in the sequence adopted.

V.

In the appreciation of the value of groups, or at least those of ordinal rank, the views of Linnæus have been generally adopted by therologists as far as they could be consistently with the more advanced stage of knowledge, and an attempt, instinctive or avowed, has been made to apply the views which the great founder of systematic biology had vaguely conceived; the modifications have, however, been necessarily very great, and the groups which the intuitive genius of Linnæus perceived have only been rigorously defined, eliminated of heterogeneous elements, and correctly weighed as to relative value within recent times. It may be added that if the writer has especially introduced the proposition now explained in this article, it is only because some eminent and justly esteemed naturalists of this country have taken another view of the appreciation of the groups recognized by the father of the modern taxonomy.

Terminology.

In order to meet the exigencies of a taxonomic valuation of groups, the terms superorder and superfamily are introduced; their intended range may be best perceived by reference to their application in the present article.

Also, for the purpose of exhibiting in the descriptions, the *tendencies* as well as primitive characters of groups, and those characteristics which really materially influence the systematist in his conclusions, although he may not avail himself of them on account of their failure in universality, the terms archetypically, attypically, and etypically are used.

Archetypical characters are those which a group derives from its progenitor, and with which it commences, but which in much modified descendants are lost; such, for example, is the dental formula of the Educabilia ($M \frac{3}{3}$ $PM \frac{4}{4}$ $C \frac{1}{1}$ $I \frac{3}{3} \times 2$), — a formula, as shown by Owen, very prevalent among the early members of the group, but generally departed from more or less in those of the existing faunas.

Attypical characters are those to the acquisition of which, as a matter of fact, we find that forms, in their journey to a specialized condition, tend; thus, the Pecora or Ruminants have lost upper incisors, and this character seemed to entitle them, in the opinion of the early cultivators of zoölogy, to ordinal differentiation: we now recognize the comparatively slight value of the character, but itself and the tendency thereto are still significant, and influence, insensibly or openly, a more complete recognition of the group in part so characterized. Another example is furnished by the Solidungula, in which the specialized Equidæ formerly furnished the characters for the distinction of the group: the progress of discovery has, however, compelled a modification of diagnoses; but we are still influenced by the culmination of the characters distinctive of the horses, and it is proper to specify the tendencies thereto in a diagnostic form.

Etypical characters are exceptional ones, and which are exhibited by an eccentric offshoot from the common stock of a group. Such are the dental characters exhibited by certain Lemurids, the Aye-aye, &c.

Descriptive.

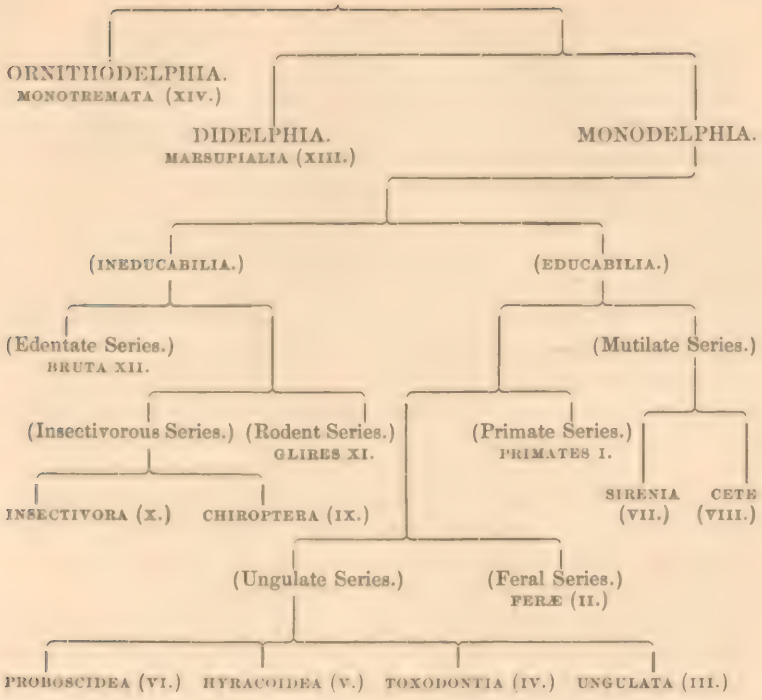
After the preceding introduction, the descriptions and reasons for combinations of the following groups may be more intelligible. The names in italics indicate extinct types.

The class of mammals is definable by the following characters, most of which have been especially exposed by Professor Huxley.

Mammalia.

Abranchiate Vertebrates with a brain whose cerebral hemispheres are more or less connected (and in nearly inverse ratio) by an anterior commissure, and a superior transverse commissure (corpus callosum); the latter more or less roofing in the ventricles. Skull with two condyles, chiefly developed on the exoccipital elements (one on each side of the foramen magnum): with the malleus and incus superadded as specialized auditory ossicles: and the lower jaw (composed of a pair of simple rami) articulated directly by convex condyles with the squamosal bones. Lungs and heart in the thorax, and separated from the abdominal viscera by a muscular diaphragm: aorta single and reflected over the left bronchus: blood with red nonnucleated blood-corpuscles undergoing a complete circulation; entirely received and transmitted by the right half of the quadrilocular heart to the lungs for aeration (and thus warmed), and afterwards returned by the other half through the system. Dermal appendages developed as hairs. Viviparous: young nourished after birth by a fluid (milk) secreted in peculiar glands (mammary) by the mother.

The relations of the several primary groups of the class may be more readily understood from a glance at the subjoined table, which will also serve as a genealogical table for those who accept the doctrine of evolution. The more generalized forms — and therefore the quasi-eldest — are represented by the left branches. It may not be entirely superfluous to remark that adaptive special modifications must be subordinated to morphological in every case: it will therefore be understood that although the Cetacean is, in a teleological sense, the most specialized form of mammals, it is a divergent from the same common stock as the Carnivores and other Educabilia, and must be contrasted morphologically with them alone and not with the rest of the mammals; the bat, another extremely specialized form, is in like manner a derivative from the same common stock as the Insectivores, and therefore to be contrasted with them alone.



Sub-Class Monodelphia.

Brain with the cerebral hemispheres connected by a more or less well-developed corpus callosum composed of a body as well as a folded psalterial portion, and a reduced anterior commissure; with a well-developed septum. Sternum with no element in front of the manubrium or presternum. Coracoid not connected with the sternum, but early anchylosed with and developed as a simple process of the scapula. Testes variable in position, but the vasa deferentia open directly or indirectly into a distinct and complete urethra (and not into a cloacal cavity). Ureters discharge directly into the bladder the renal secretion, which thence passes into the urethra. Oviducts debouching into a single vagina. Mammary glands with well-developed nipples. Young retained within the womb till of considerable size and nearly perfect development, and deriving its nourishment from the mother through the intervention of a "placenta" (developed from the allantois) till birth. Scrotum never in front of penis.

Super-Order Educabilia.

Brain with a relatively large cerebrum, behind overlapping much or all of the cerebellum, and in front much or all of the olfactory lobes; corpus callosum (attypically) continued horizontally backwards to or beyond the vertical of the hippocampal sulcus, developing in front a well-defined recurved rostrum.

(*Educabilia Quadripedia.*)

Posterior members and pelvis well developed. Periotic and tympanic bones articulated with the squamosal: etypically free and otherwise modified (*e.g.*, *Tapiridæ*).

(*Primate Series.*)

I. Order Primates.

Brain with a calcarine sulcus, giving rise to a hippocampus minor within the posterior cornu (when present) of the ventricle. Members almost or entirely exserted outside of the common abdominal integument. Digits with corneous appendages developed as claws (*i.e.*, compressed) or, attypically, as nails (*i.e.*, depressed). First digit (great toe) of hind foot (pes) enlarged, opposable to the others (in man, resuming parallelism with them), always furnished with a nail. Clavicles completely developed. Teeth of three kinds (canines of second set exceptionally atrophied), all encased in enamel; molars rooted. Incisors four in each jaw: etypically, two — or all — in upper jaw suppressed. Placenta deciduate, discoidal.

Contains eight families, representing two sub-orders: Anthropoidea, with five families, and Lemuroidea with three families.

SUBORDER ANTHROPOIDEA.

Superfamily Bimana.

1 Hominidæ.

Superfamily Simiæ.

2 Simiidæ.
3 Cynopithecidæ.
4 Cebidæ.
5 Midídæ.

SUBORDER PROSIMIÆ.

Superfamily Lemuroidea.

6 Lemuridæ.
7 Tarsiidæ.

Superfamily Dantentonioidea.

8 Dantentoniidæ-Chiromyidæ.

(*Feral Series.*)

II. Order Feræ.

Brain with no calcarine sulcus. Legs with the proximal joints (humerus and femur) more or less enclosed in the common abdominal integument. Digits with corneous appendages developed as claws: first digit of hind foot attypically reduced or atrophied: etypically hypertrophied (*e.g.*, *Pinnipedia*). Clavicles none, or rudimentary. Teeth of three kinds, all encased in enamel: canines specialized and robust; molars attypically adapted for carnivorous diet, one ($^{p\ m}_{m\ 1}{}^{4}$) or more in each jaw being sectorial, generally followed by tubercular ones. Incisors archetypically six in each jaw, exceptionally two or more suppressed. Placenta deciduate, zonary. Scaphoid and lunar consolidated into one bone.

Contains nineteen families, representing two suborders: Carnivora or Fissipedia, with sixteen families, three of which are extinct, and Pinnipedia with three families.

SUBORDER FISSIPEDIA.

Superfamily Aeluroidea.

9	Felidæ.	12	Hyænidæ.
10	Cryptoproctidæ.	13	Viverridæ.
11	Protelidæ.	14	Eupleridæ.

Superfamily Cynoidea.

15 Canidæ.

Superfamily Arctoidea.

16	Mustelidæ.	19	Cercoleptidæ.
17	Ursidæ.	20	Procyonidæ.
18	Aeluridæ.	21	Bassaridide.

Fissipedia incertæ sedis.

22	*Simocyonidæ.*	24	*Hyænodontidæ.*
23	*Arctocyonidæ.*		

SUBORDER PINNIPEDIA.

(*Diverging Series.*)

Superfamily Phocoidea.

25	Otariidæ.	26	Phocidæ.

Superfamily Rosmaroidea.

27 Rosmaridæ.

(*Ungulate Series.*)

Brain with no calcarine sulcus. Legs with the proximal joints more or less enclosed in the common abdominal integuments. Digits with corneous appendages developed as hoofs. Clavicles

entirely absent. Teeth of three kinds (canines and incisors of second set exceptionally in part undeveloped), all encased in enamel: molars attypically with grinding surfaces. Scaphoid and lunar separate.

III. Order Ungulata.

Incisors (archetypically $\frac{3}{3}$: often, especially in the upper jaw, reduced in number or wholly suppressed: implanted by simple roots) with incisorial crowns. Feet with inferior (or, rather, posterior) surfaces with a hairy skin continuous with the rest of the integument: carpal bones in two interlocking rows; cuneiform narrow, and affording a diminished surface of attachment forwards for the ulna (which is retrorse beside the radius); unciform and lunar articulating with each other and interposed between the cuneiform and magnum: hind foot with the astragalus at its anterior portion scarcely deflected inwards, articulating more or less with the cuboid as well as navicular: toes (not more than four — d 2 to d 5 — completely developed) with terminal joints encased in thick hoofs. Placenta non-deciduate (diffuse or cotyledonary).

Contains twenty-nine families, representing two suborders; Artiodactyli, with nineteen families, of which eight are extinct, and Perissodactyli with ten families, of which seven are extinct.

SUBORDER ARTIODACTYLI.

PECORA.

Superfamily Chalicotherioidea.

27*a* *Chalicotheriidæ.*

Pecora tylopoda.

28 Camelidæ.

Pecora unguligrada.

Superfamily Giraffoidea.

29 Giraffidæ.

Superfamily Bovidea.

30 Saigiidæ. | 32 Antilocapridæ.
31 Bovidæ. | 33 Cervidæ.

Superfamily Traguloidea.

34 Tragulidæ.

Pecora unguligrada incertæ sedis.

35 *Siratheriidæ.* | 36 *Helladotheriidæ.*

Pecora dentata.

Superfamily Oreodontoidea.

37 *Oreodontidæ.*

Superfamily Anoplotherioidea.

38 *Anoplotheriidæ.* | 39 *Dichobunidæ.*

OMNIVORA.

Superfamily Obesa.

40 Hippopotamidæ. | 41 *Merycopotamidæ.*

Superfamily Setifera.

42 Phaochœridæ. | 44 Dicotylidæ.
43 Suidæ. |

Superfamily Anthracotherioidea.

45 *Anthracotheriidæ.*

SUBORDER PERISSODACTYLI.

Superfamily Solidungula.

46 Equidæ. | 47 *Anchitheriidæ.*

Superfamily Rhinocerotoidea.

48 Rhinocerotidæ. | 49 *Macraucheniidæ.*
50 *Palæotheriidæ.*

Superfamily Tapiroidea.

51 Tapiridæ. | 52 *Lophiodontidæ.*

Superfamily Pliolophoidea.

53 *Pliolophidæ.*

Perissodactyli incertæ sedis.

54 *Elasmotheriidæ.* | 54*a* *Anchippodontidæ.*

IV. Order Toxodontia.

Incisors ($\frac{3}{3}$ or $\frac{4}{4}$, variable as to insertion), with incisorial crowns. Feet? carpal bones? hind foot with the astragalus at its anterior portion inclined obliquely inwards, articulating in front only with the navicular; (calcaneum with an extensive upwards surface for the articulation of the fibula, and with a large lateral process articulating in front with the astragalus. Molars of upper jaw, broad and extending into an externo-anterior angle; of lower jaw, narrow and continuous in a uniform row).

Contains two families, both of which are extinct.

55 *Nesodontidæ.* | 56 *Toxodontidæ.*

V. Order Hyracoidea.

Incisors ($\frac{1}{2}$) of upper jaw next to symphysis (with persistent pulps) long and curved; those of lower jaw straight and normal. Feet with inferior surfaces furnished with pads (as in Rodents and Carnivores): carpal bones in two interlocking rows: cuneiform extending inwards (and articulating with magnum), and affording an enlarged surface of attachment forwards for the ulna (which is antrorsely twisted); unciform and lunar separated by the interposition of the cuneiform and magnum: hind foot with the astragalus

at its anterior portion extended, and, as a whole, much deflected inwards, articulating in front only with the navicular; toes (four to the front feet, three to the hind) with terminal phalanges encased in hoofs (inner nail of hind foot curved). Placenta deciduate, zonary.

Contains one family.

57 Hyracidæ.

VI. Order Proboscidea.

Incisors ($\frac{2}{0}$, or, in extinct forms, $\frac{3}{2}$ or $\frac{2}{2}$, renewed from persistent pulps), developed as long tusks curved outwards. Feet with palmar and plantar surfaces invested in extended pad-like integuments, which also underlie the toes: carpal bones in two regular (not interlocking) rows, broad and short; cuneiform extended inwards, broad, and furnishing an enlarged surface of attachment forwards for the ulna (which is antrorsely produced). Unciform directly in front of cuneiform, and magnum directly in front of lunar: hind foot with the astragalus at its anterior portion very short (convex), and not deflected inwards, articulating in front only with the navicular: toes (five to each foot, in known forms), encased in broad shallow hoofs. Placenta deciduate, zonary. (Snout produced into a very long proboscis. Legs mostly exserted outside the abdominal integument; and with the proximal and succeeding joints extensible in the same line.)

Contains two families, one of which is extinct.

58 Elephantidæ | 59 *Dinotheriidæ.*

(*Diverging Series.*)

(*Educabilia Mutilata.*)

(*Mutilate Series.*)

Posterior members and pelvis more or less completely atrophied; the form of the body being fish-like, furnished with a horizontal tail, and specialized for progression in the water. Periotic and tympanic bones anchylosed together, but not with the squamosal.

VII. Order Sirenia.

Brain narrow. Skull with the foramen magnum posterior, directed somewhat downwards: supra-occipital nearly vertical and not extending forwards, the parietals meeting and interposed be-

tween it and the frontal. Periotic with a posterior irregularly rounded part; tympanic annuliform. Lower jaw with well-developed ascending rami and normal transverse condyles and coronoid processes. Lateral teeth molar, and adapted to trituration of herbage. Neck moderate; second cervical vertebra with an odontoid process. Anterior members moderately long, flexed at the elbow; with carpal bones and phalanges directly articulated with the adjoining ones; and with normal digits. Mammæ two, pectoral. (Heart deeply fissured between the ventricles.)

Contains four families, one of which is certainly, and another probably, extinct.

SUPERFAMILY HALICOROIDEA.

60 *Halitheriidæ.* | 62 Rhytinidæ.
61 Halicoridæ. |

SUPERFAMILY TRICHECHOIDEA.

63 Trichechidæ-Manatidæ.

VIII. ORDER CETE.

Brain broad. Skull with the foramen magnum entirely posterior, directed somewhat upwards: supra-occipital very large, sloping forwards, and (attypically) extending forwards over or between the frontals. Periotic attenuated backwards; tympanic solid, entire. Lower jaw with no ascending ramus, with its narrow condyles at the posterior extremities or angles of the rami, and with only rudimentary coronoid processes. Teeth (lateral) conic or compressed. Neck attypically very short; second cervical vertebra with no odontoid process. Anterior members (attypically) abbreviated, extended backwards in a continuous line; with carpal bones and phalanges often separated by cartilage; and with the second digit composed of more than three phalanges. Mammæ two, inguinal.

Contains ten families, representing three suborders; ZEUGLODONTIA with two families, both extinct; DENTICETE with six families, one of which is extinct; and MYSTICETE with two families.

SUBORDER ZEUGLODONTIA.

64 *Basilosauridæ.* | 65 *Cynorcidæ.*

SUBORDER DENTICETE.

SUPERFAMILY DELPHINOIDEA.

66 Platanistidæ. | 68 Delphinidæ.
67 Iniidæ. | 69 Ziphiidæ.

SUPERFAMILY PHYSETEROIDEA.

70 Physeteridæ.

SUPERFAMILY RHABDOSTEOIDEA.

71 *Rhabdosteidæ.*

SUBORDER MYSTICETE.

72 Balænopteridæ. | 73 Balænidæ.

Superorder Ineducabilia.

Brain with a relatively small cerebrum, leaving behind much of the cerebellum exposed, and in front much of the olfactory lobes: corpus callosum extending more or less obliquely upwards and terminating before the vertical of the hippocampal sulcus, with no well-defined rostrum in front.

(*Insectivorous Series.*)

Teeth encased in enamel: incisors (very variable as to number) without persistent pulps: canines present (but sometimes modified in form): molars attypically with pointed cusps. Lower jaw with condyles transverse, received into special glenoid sockets. Placenta discoidal deciduate.

IX. ORDER CHIROPTERA.

Anterior members adapted for flight: the ulna and radius being united, and the metacarpal bones and phalanges — second to fifth — much elongated; the whole sustaining a very thin leathery skin arising from the sides of the body, and extending backwards on the hind members, down to their tarsi. (Mammæ pectoral).

Contains nine families, representing two suborders; FRUGIVORA with one family, and ANIMALIVORA with eight families.

SUBORDER ANIMALIVORA.

SUPERFAMILY DESMODOIDEA.

74 Desmodidæ.

SUPERFAMILY VESPERTILIONOIDEA.

75 Phyllostomidæ.
76 Mormopidæ.
77 Rhinolophidæ.
78 Megadermidæ.
79 Vespertilionidæ.
80 Molossidæ.
81 Noctilionidæ.

SUBORDER FRUGIVORA.

82 Pteropodidæ.

X. Order Insectivora.

Anterior as well as posterior members adapted more or less for progression on land: the ulna and radius entirely or partly separated: metacarpal bones and phalanges normally developed. (Mammæ abdominal: etypically—in Dermoptera, &c.— pectoral).

Contains ten families referable to two suborders; Dermaptera, with one family, and *Insectivora vera*, with nine families, one of which is extinct.

SUBORDER DERMOPTERA.

83 Galeopithecidæ.

SUBORDER INSECTIVORA VERA.

Superfamily Soricoidea.

84 Talpidæ. | 85 Soricidæ.

Superfamily Erinaceoidea.

86 Erinaceidæ.

Superfamily Centetoidea.

87 Centetidæ. | 88 Potamogalidæ.

Superfamily Chrysochloridoidea.

89 Chrysochlorididæ.

Superfamily Macroscelidoidea.

90 Macroscelididæ. | 91 Tupayidæ.

Insectivora incertæ sedis.

92 *Leptictidæ*.

(*Rodent Series.*)

XI. Order Glires.

Teeth encased in enamel: incisors ($\frac{2}{2}$; exceptionally, also two supplementary posterior teeth) continually reproduced from persistent pulps, and growing in a circular direction: canines null: molars attypically with ridged surfaces. Lower jaw with condyles longitudinal, and not received in special glenoid cavities, but gliding freely backwards and forwards. Members and feet ambulatorial. Placenta discoidal deciduate.

Contains sixteen families, representing two suborders: Simplicidentati, with fourteen families, and Duplicidentati, with two families.

SUBORDER SIMPLICIDENTATI.

Superfamily Lophiomyoidea.

93 Lophiomyidæ.

SUPERFAMILY MYOIDEA.

94 Pedetidæ.
95 Dipodidæ.
96 Jaculidæ.
97 Muridæ.

SUPERFAMILY MYOXOIDEA.

98 Myoxidæ.

SUPERFAMILY SACCOMYOIDEA.

99 Saccomyidæ.
100 Geomyidæ.

SUPERFAMILY CASTOROIDEA.

101 Castoridæ.

SUPERFAMILY SCIUROIDEA.

102 Sciuridæ.

SUPERFAMILY ANOMALUROIDEA.

103 Anomaluridæ.

SUPERFAMILY HAPLOODONTOIDEA.

104 Haploodontidæ.

SUPERFAMILY HYSTRICOIDEA.

105 Spalacopodidæ.
106 Hystricidæ.
107 Dasyproctidæ.
108 Caviidæ.
109 Hydrochœridæ.
110 Chinchillidæ.

SUPERORDER DUPLICIDENTATI.

111 Leporidæ.
112 Lagomyidæ.

(*Edentate Series.*)

XII. ORDER BRUTA.

Teeth (when developed) not encased in enamel: incisors typically absent (lateral present in Dasypus): molars variable: members and feet ambulatorial (modified often for grasping and digging). Placenta variable (discoidal deciduate in *Orycteropodidæ* and *Dasypodidæ;* diffuse deciduate in *Manididæ;* and cotyledonous non-deciduate? in *Bradypodidæ*).

Contains nine families, representing five suborders. VERMILINGUIA, with one family; SQUAMATA, with one family; FODIENTIA, with one family; TARDIGRADA, with two families, one of which is extinct, and LORICATA, with three families, one of which is extinct; also, one extinct family of undetermined affinities.

SUBORDER VERMILINGUIA.

113 Myrmecophagidæ.

SUBORDER SQUAMATA.

114 Manididæ.

SUBORDER FODIENTIA.

115 Orycteropodidæ.

SUBORDER TARDIGRADA.

116 Bradypodidæ. | 117 *Megatheriidæ.*

SUBORDER LORICATA.

118 Dasypodidæ. | 120 *Hoplophoridæ.*
119 Chlamydophoridæ. |

BRUTA INCERTÆ SEDIS.

121 *Ancylotheriidæ.*

Subclass Didelphia.

Brain with the cerebral hemispheres chiefly connected by a well-developed anterior commissure, the corpus callosum being rudimentary, and with a moderately developed septum. Sternum with no element in front of the manubrium. Coracoid not connected with the sternum, but early anchylosed with and developed as a simple process of the scapula. Oviducts debouching into separate vaginas. Testes chiefly abdominal; vasa deferentia opening into a distinct urethra. Ureters discharge directly into the bladder the renal secretion, which thence passes into the urethra. Mammary glands with well-developed nipples. Young born when of very small size and imperfect development; never connected by a placenta with the mother, but attached by her to the nipple when born, from which the milk is forced by herself into the mouth of the young. Scrotum in front of penis.

XIII. ORDER MARSUPIALIA.

Only order of the subclass. Contains thirteen families, referable to four suborders: RHIZOPHAGA, with one family; SYNDACTYLI, with seven families, two of which are extinct; DASYUROMORPHIA, with two families; and DIDELPHIMORPHIA with one family; also two extinct families of doubtful affinities.

SUBORDER RHIZOPHAGA.

122 Phascolomyidæ.

SUBORDER SYNDACTYLI.

(*Pœphaga.*)

123 Macropodidæ.

(*Carpophaga.*)

124 Tarsipedidæ.
125 Phalangstidæ.
126 Phascolarctidæ.
127 *Diprotodontidæ.*
128 *Thylacoleonidæ.*

(*Entomophaga.*)

129 Peramelidæ.

SUBORDER DASYUROMORPHIA.

130 Dasyuridæ. | 131 Myrmecobiidæ.

SUBORDER DIDELPHIMORPHIA.

132 Didelphididæ.

MARSUPIALIA INCERTÆ SEDIS.

133 *Plogiaulacidæ.* | 134 *Dromotheriidæ.*

Subclass Ornithodelphia.

Brain with the cerebral hemispheres chiefly connected by a well-developed anterior commissure, the corpus callosum being very rudimentary, and with no defined psalterial fibres; with the septum very much reduced in size. (Flower.) Sternum with a peculiar T-shaped bone (the episternum or interclavicle) in advance of the manubrium or presternum. Coracoid extending from the clavicle to the sternum, and only towards maturity anchylosed with the scapula. The oviducts, enlarged below into uterine pouches, but opening separately from one another (as in oviparous vertebrates), debouch, not into a distinct vagina, but into a cloacal chamber, common to the urinary and genital products, and to the fæces. Testes abdominal in position throughout life, and the vasa deferentia open into the cloaca, and not into a distinct urethral passage. Ureters pour the renal secretion, not into the bladder, which is connected with the upper extremity of the cloaca, but into the latter cavity itself. Mammary glands with no distinct nipples. (Huxley.)

XIV. ORDER MONOTREMATA.

Only order of the subclass. Contains two families.

135 Tachyglossidæ. | 136 Ornithorhynchidæ.